EXPLOSIVE HAZARD REDUCTION

1. Need: A critical need exists for the reduction of risks associated with storing, handling, loading and transporting munitions in peace, as well as war. Base closings and mission changes have increased the number of aircraft, missions, and consequently the requirement for munitions present on the remaining air bases. Bases were already operating under waivers and exemptions to minimum explosives safety criteria, even in peacetime, and the threat posed by our munitions to our warfighting forces has increased significantly. This threat is increased when additional forces deploy to these bases in time of increased readiness or conflict. On some bases the threat has increased to the point that collateral damage from our own munitions (even during peace), caused by an accident or enemy ordnance, could destroy or render ineffective most of the combat assets on the base. The same situation exists and is heightened for deployed forces operating from bare bases or civilian airfields during contingency operations. The reorganized, down-sized, "lean-and-mean" Air Force does not possess the hardware or personnel resources to replace these losses and serious tactical damage can result from a single accident, terrorist action or enemy attack. Additionally, off-base civilian populations are exposed to serious risk of death and injury from US munitions, even during peacetime operations. An explosives accident which causes civilian casualties or death could have disastrous strategic political and military consequences.

2. Objectives/Goals: The objective of Explosive Hazard Reduction (EHR) is to reduce the Maximum Credible Event (MCE) should an inadvertent detonation with munitions occur. MCE is defined by the DOD as the worst single event likely to occur from a given quantity of munitions or explosives. This is being achieved by development of technologies and procedures, and by applying both new and existing technologies and procedures through site/explosives hazard reduction planning practices. The result will be improved survivability, sustainablility, and operability of US air bases and Contingency Operating Locations (COLs). As defined in the IM Master Plan, the Insensitive Munition (IM) Program encompasses two major goals:

a. The USAF's immediate goal is to reduce the hazards presented by inventory munitions by developing and incorporating energy suppression devices such as barriers and diverters, redesigning munitions packaging, and applying innovative storage and handling techniques. These activities may permit the reduction of safety imposed restrictions (quantity-distance (Q-D) limitations) associated with these munitions.

b. The long-range goal of the program is to complete transition to insensitive or less sensitive munitions in all major weapon systems as soon as practical without significant reduction in operational effectiveness. IM requirements will be included in all new munitions programs through MIL Standards, Specifications, and PMD direction. To the extent practical, all munitions shall be made to meet the IM criteria (MIL STD 2105, Hazard Assessment Tests for Non-Nuclear Ordnance). Practical constraints include, but are not limited to technical feasibility, affordability, inventory, shelf-life, and return on investment. If a munition cannot be designed to be insensitive, it will be made less sensitive by incorporation of appropriate and feasible IM design features. Munitions that are

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not made insensitive must be examined periodically to determine if emerging technology or other factors can make the munition less sensitive.

3. The program required to complement the immediate goal is presented in this paper. A validated program to complement the long-range goal for explosives and propellants has not been established. The EHR Program Office, when directed, is ready to develop this program and execute it.

4. The objective of the current (near-term) EHR program is to pursue the program goals through three major elements:

a. Implementation: Through this element the EHR Program is implemented. Tasks performed under this element include: Munitions hazard reduction (MHR) planning, identification, and execution of RD&A projects, development/implementation of directives and inputs to appropriate MIL STDs to resolve user(s) munitions hazards.

b. Technology: The EHR Program Office conducts technology efforts to reduce munitions hazards, particularly those needed to reduce the hazards of munitions in the inventory. The major effort is toward mitigation of sympathetic detonation. Technology in this area is very limited. The EHR Program Office tracks closely the development of insensitive high explosives (IHE) currently being worked in DOD laboratories. As these IHE mature, the EHR Program Office will recommend consideration for their inclusion into weapons under development via Engineering, Manufacturing, and Development (EMD) or other programs.

c. Testing: Testing, specifically munitions characterization, is needed to support technology efforts and, in many cases, can lead to Q-D reductions. Many munitions were not fully tested during development and C/D 1.1 was assumed. In fact, many clear zone requirements are based on "default rules". One of the EHR Program Office's major objectives is to define the "real clear zone where possible", and identify the "real hazard" presented to air base operations by our munitions. This element is conducted with close support from AFSA/SEWV and the DDESB.

5. In addition, the EHR Program Office provides the following services to support the implementation of the baseline MHR:

a. Assists preparation of site plans.

b. Sets up the Explosive Siting System developed by the EHR Program Office, provides training and follow-on tech support.

c. Prepares 943 forms (munitions site plan) and 1391 forms (facilities cost estimates) to support recommended EHR actions.

EHR PAPER

1. Introduction: The objective of the Explosive Hazard Reduction (EHR) Program is to identify and reduce the risks associated with storing, handling, loading, and transporting Air Force munitions. The thrust of this program is to gain and sustain full mission capabilities by:

a. Being able to store all required munitions on base.

b. Increasing number of munitions at operating points.

(1) Build up areas
(2) Transportation points
(3) Hardened Aircraft Shelter areas

c. Minimizing the impact of a munition event (caused by accident or attack) on warfighting assets.

2. The program is accomplished by reducing the Maximum Creditable Event (MCE) presented by inventory munitions by developing and incorporating energy suppression devices, packaging redesign, applying innovative storage and handling techniques, and utilization of storage facilities. The program is supported by a technical team of experts that conduct Air Base munitions hazard reduction (MHR) plans which are presented to the Wing Commander as a Staff Assistance Report. These SARs provide the Wing Commander:

a. Identification, quantification and prioritization of threats and operational restrictions posed by the presence of munitions stocks on base on mission accomplishment.

b. Provide recommended approaches to reduce or mitigate these threats and restrictions.

These SARs also identify technology shortfalls for the EHR Program Office which will result in RD&A projects to solve munitions hazards problems.

PROGRAM IMPLEMENTATION

A. Munition Hazard Reduction Planning

1. The key to solving our explosives safety dilemma is to start with good explosives safety site planning. Site planning is a very complicated, time consuming process. An explosive site plan for a single building often requires six or more months from inception to final approval. Re-siting or baselining an entire air base would take more than three years for a qualified safety professional, using today's methods. We need to baseline each of our bases to determine what problems exist. We can then resolve or mitigate the problems. Most importantly, the Wing Commander will know the impact of the various explosives safety violations and can prioritize their resolution. This seems like an impossible task until you consider that computer aided site planning exists, and is in use in the Air Force.

2. This capability was developed by the Air Force Explosives Hazard Reduction Program. Part of this effort is the computer aided explosives site planning capability, Assessment System for Hazard Surveys (ASHS). ASHS is fielded, and in use by the base explosives safety personnel at Hill AFB. Using this system, Hill AFB has reduced its explosives safety violations from more than a thousand, six months ago, to one now. The Hill AFB Safety Office, in conjunction with civil engineering, has also instituted what they call "drive thru sighting". A customer (CE, LG, etc.) with a proposed facility siting can sit down with the safety professional, watch the analysis using ASHS, discuss alternatives to the proposed site, and have a completed siting the same day, sometimes within hours. This is what we have needed for many years.

3. ASHS gives safety and civil engineering personnel an in-depth view of the base and its explosives safety problems, as well as areas and facilities not effected by the explosives clear zones. ASHS displays the problems and the effects of proposed solutions graphically on a computer displayed map and textually within a database. These solutions can also result in reduced clear zones which free up space for other badly needed base facilities. The hazard analysis generated by the software shows the impact of an accident on other facilities, and aids decision-makers in prioritizing corrective action. Creating site plans is a matter of selecting the facility or facilities being sited and telling the computer to prepare the forms. The user can add comments or text as appropriate and then print the forms. The maps can be output to a printer or plotter.

4. ASHS does not replace the explosives safety professional. It quickly applies the explosives safety criteria, points out areas of non-compliance, and in some cases points the user to solutions. The value of ASHS is the speed and accuracy it gives to explosives facility planning. This gives the explosives safety person time to improve the explosives safety health of the air base through better planning and more monitoring.

5. ASHS has the potential to be used for deployment planning. The EHR team demonstrated both the deployment and site planning capabilities of ASHS at Sembach AB in May 1995. The initial approach to deployment planning capability was also impressive. Even though the software was not developed specifically for this purpose, a three aircraft deployment to a civilian airfield was completed in about two hours. This included scanning the base map and siting:

explosives storage facilities, a hot cargo pad, munitions operating facilities, logistics aircraft parking, and combat aircraft parking. Additional enhancements to this software could easily accommodate the many other deployment/bare base planning capabilities. Using a laptop computer and a scanned map, the initial beddown for a deployment to a previously unplanned base could be planned en route. Known deployments could be preplanned and any last minute changes could be accommodated quickly.

6. The EHR Program Office has completed munition hazards analysis/planning for Kunsan AFB, Osan AFB, Hill AFB, and Misawa AFB. Ongoing projects include Aviano AB, Nellis AFB, and Incirlik AB.

7. For an in-depth discussion of explosive facility site planning and analysis, the work at Hill AFB was selected. In order to provide Hill AFB with a near-term solution to their explosives site planning needs, software developed to create Explosives Hazard Reduction (EHR) plans has been modified for their use. The commercial database and mapping systems along with the custom programming necessary to adapt them for this purpose are together referred to as ASHS or Assessment System for Hazard Surveys. A block diagram of the ASHS system is presented in Figure Two and is broken into input, process, and output sections. It was delivered in October of 1993 with the data for Hill AFB already loaded from the EHR plan in progress. Reference and tutorial manuals for the system and initial training was provided to familiarize the Safety Office users with system operation. A Phase II version was delivered in the 4th quarter of 1994 which offered additional capabilities and enhanced the system's ease of use.

8. System capabilities include the ability to automatically determine explosives safety criteria violations and to highlight areas on the map where new facilities may be sited. Safety violations may be analyzed textually through spreadsheet-like database screens, or graphically using system generated clear zone areas on a computer map. Some of the documents that the system is capable of generating include the AF Form 943, a custom hazard analysis report, and an explosives risk assessment report appropriate for wing commanders. The system is capable of producing plotted base maps at any required scale.

9. The mapping system expedites the process of digitizing base maps by providing templates for standard explosives enclosure and other facilities. It can generate a report with the distances and exposures between each potential explosion site (PES) and all respective exposed sites (ES). The report will also show if a particular building pair is barricaded, and notes the IDs of the barricades involved so that their rated capacities can be checked.

10. The database system imports building pair data from the mapping system and streamlines data entry of their facility information such as sited weights, waivers and exemptions. Explosives safety criteria is pre-loaded into the database and can be modified by the user when criteria changes occur. The database calculates required quantity -distance (Q-D) separations, determines which facilities are not in compliance and provides both built in and user defined searches. Information is output to the map which automatically creates clear zones. Lists of building pair data can be exported for inclusion in reports. Several built in report formats such as AF Form 943s are available as well as the capability to easily design custom reports that can be

printed on a laser printer. The system also generates risk assessments and estimated damage for each facility.

11. Anyone who has attempted to create or analyze an explosives site plan with a ruler and a calculator can testify that it is a process which begs to be computerized. Not only is it tedious and error prone, but often the entire process must be repeated when the slightest change is introduced. Additionally, there is paperwork to type and revise with endless columns of figures that must be checked and rechecked. The application of a database and a computerized mapping system or Geographic Information System (GIS) to this problem has resulted in increased productivity, decreased error, and the ability to detect problems that humans alone might overlook. An additional benefit is the computerized analysis ability to quickly evaluate several different alternatives to determine the best solution for siting a facility or resolving a criteria violation. This ability to rapidly evaluate different "what-if" scenarios is where the computer really pays for itself many times over in man-hours and reduced construction costs.

12. It takes more explosives safety expertise, mapping and database skill to initially set up the system than it does to use it. The cost in man-hours of bringing up the system from scratch, for a base, without the data being pre-loaded by the EHR planning team, is about one man-year. If digitized maps and electronic data are available, this time can be reduced. Phase II enhancements make the system easier to use, but not necessarily easier to set up. Initial startup costs may never go lower due to the large amounts of data required by the analysis.

13. The system is not designed to replace the explosives site planner but to provide a tool to increase the speed and accuracy or eliminate tedious form and map preparation, and provide analytical capabilities not previously available. The operator will still require knowledge of explosives safety as well as being familiar with the use of the computer mapping and the database systems. However, after an initial familiarization period, at least a four-fold increase in productivity over manual methods can be expected.

14. In spite of all of these advantages, computerized site planning may not always be appropriate for certain areas, such as those with inadequate staffing or rapid turnover of personnel. In these areas, centralized site planning could be performed by the MAJCOM or Numbered Air Force Explosives Safety Office.

15. The hardware and commercial software required to support the system is currently running about $20K per workstation for full capability, about $6K of this is to support the ability to digitize and plot computerized maps, which may not be necessary if the local CE office has adequate digital mapping capability.

B. Storage Planning System

1. In May of 1993, the development of a new software product, called Storage Planning System (SPS), was started. SPS was developed in support of 649 MMTS/LIWAS to aid in the depot storage planning effort at Hill AFB, UT and was funded by PRAM. The purpose of SPS is to provide tools which will allow the storage planner to perform, more efficiently, some of the functions which are presently being done manually. SPS downloads the latest storage data from

the Requirements Data Base (RDB). This database is used to track explosives inventory and work orders and is unique to Hill AFB. A potential future capability of SPS is to be able to interface with CAS-B which is used by some units at Hill AFB and other Air Force bases worldwide.

2. SPS allows the storage planner to graphically see the status of munitions storage facilities. SPS allows the user to see an overall view of the storage environment. This storage facilities map provides a starting point for the user to request that certain facilities of interest be highlighted and displayed at a greater level of detail. The user will be able to see all buildings which meet the desired criteria, thus narrowing down storage planning choices to aid in deciding where to store particular munitions. Figure One shows an example map and lists the data that is presented for each individual storage facility. SPS shows, for each facility, what munitions are stored and where in the facility each munition is located. SPS finds and displays all available space which meet the desired criteria such as size and shape of space and munition compatibility. The storage planner can see how storage space is presently utilized. The user is able to query SPS as to possible locations that can be used to store incoming munitions. Also displayed is space that is reserved for future expected shipments, aisle space, and dead space which cannot be used to store any munitions. Each of these spaces and munitions can be either displayed or suppressed by the user. In order to display a particular part of the facility, cutaway views are supported. The user can work towards greater levels of detail. At any point, the user can request data about an individual munition.

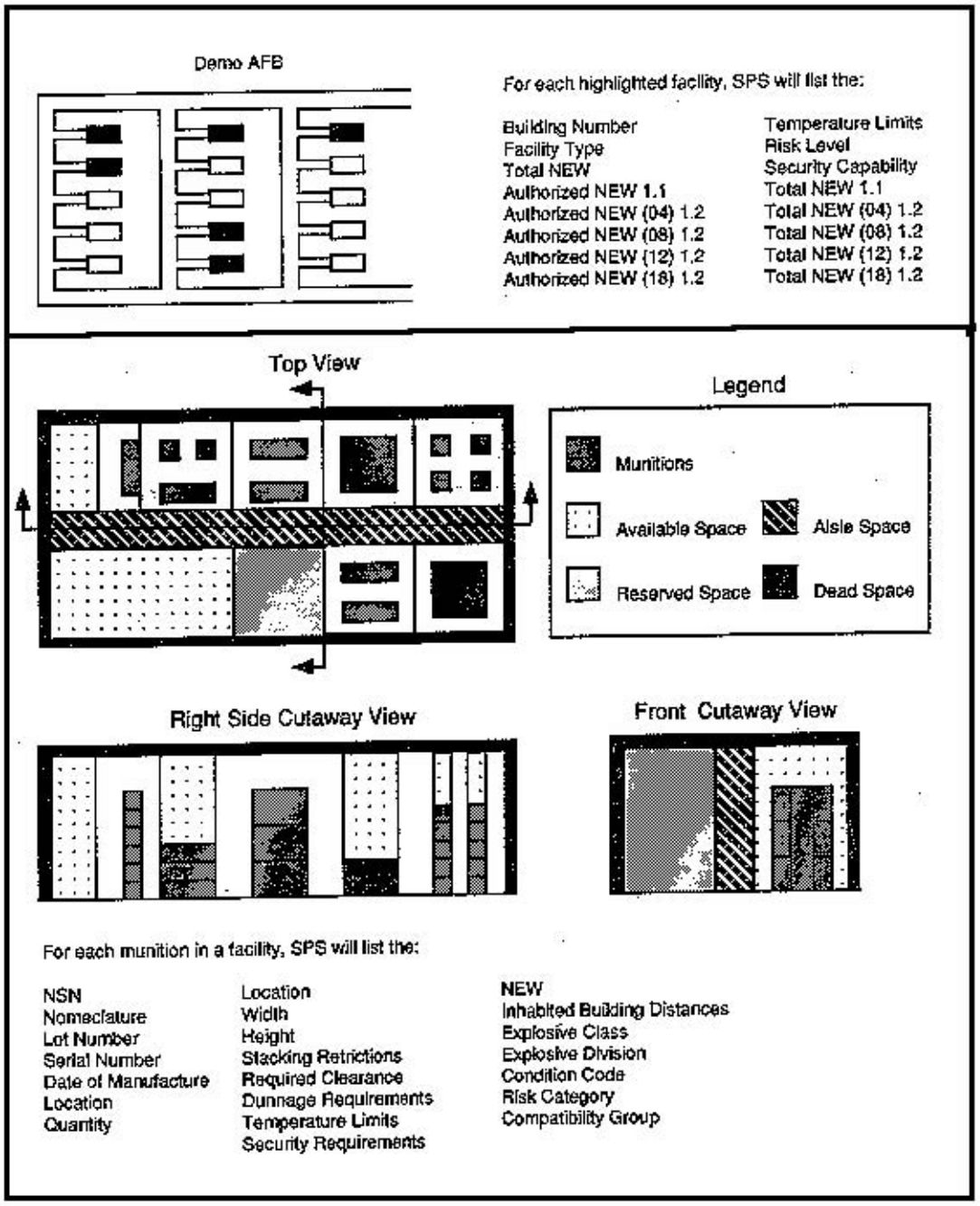
3. SPS also allows the user to manipulate the storage data. Munitions may be manually manipulated in the database using on-screen graphical tools. This allows the storage planner to graphically move munitions from one facility to another, performing "what-if" scenarios, resulting in a storage plan. A storage plan may be developed to perform such operations as opening up space for an expected incoming shipment, consolidating a lot, or moving munitions within or between storage facilities. A move within one storage plan may be dependent on moves from other storage plans and likewise may impact moves within another storage plan. It should be understood that a storage plan may not be able to stand alone, but has to work within the scope of other existing storage plans and pending jobs. SPS checks the plan to ensure that these moves do not violate storage constraints such as compatibility, NEW limits, lot number integrity, security risk levels, stacking height limits, and temperature restrictions. Various storage plans may be saved to the disk drive and loaded at a later time for further study or implementation. These storage plans can also be uploaded to the RDB at the request of the user. When this is accomplished, the RDB will generate the required work orders.

4. The heart of SPS is a powerful database system which is also easy to use. The user may construct simple or elaborate searches to locate facilities based on criteria such as risk categories, compatibility groups, temperature control limits, security alarm capabilities, reserved space, and available storage space. The user may also search for munitions based on national stock numbers (NSN), lot numbers, serial numbers, date of manufacture, explosive class and division, risk categories, conditions codes, and combinations of these. Any of this data may also be sorted. The results of these searches can be presented graphically or textually. The database also permits the user to easily design and print custom reports from the data within the database.

5. The above discussion concentrated on the user's ability to directly manipulate and control the storage planning process. However, SPS has the capability to present calculated solutions to the user. For instance, a large incoming shipment may require an extensive rewarehousing plan. SPS will work with existing best known information on the location of munitions and a list if incoming munitions and present the user with a plan to move munitions to open up space for the shipment. This computer-generated plan may be modified by the user as needed, or accepted as needed, or accepted as presented.

6. In conclusion, there are great benefits to be gained from the use of SPS. SPS can download the storage data from RDB so the storage planner can work with the latest information. SPS allows the user to easily understand the storage data, since the data can be presented graphically, so the user can see the configuration of facilities, as well as textually. The storage planner is able to manipulate this data graphically, by dragging the munitions containers with a mouse, to develop possible storage plans. SPS also presents options to the user in order to narrow the range plans. SPS greatly reduces the time required for these operations since the user can work with on-screen graphical representations rather than struggling with the text printouts, graph paper, and performing on-site inspections.

Figure 1


Demo AFB
For each highlighted facility, SPS will list the:
Building Number
Facility Type
Total NEW
Authorized NEW 1.1
Authorized NEW (04) 1.2
Authorized NEW (08) 1.2
Authorized NEW (12) 1.2
Authorized NEW (18) 1.2
Temperature Limits
Risk Level
Security Capability
Total NEW 1.1
Total NEW (04) 1.2
Total NEW (08) 1.2
Total NEW (12) 1.2
Total NEW (18) 1.2
Top View
Legend
Munitions
Available Space
Aisle Space
Reserved Space
Dead Space
Right Side Cutaway View
Front Cutaway View
For each munition in a facility, SPS will list the:
NSN
Nomeclature
Lot Number
Serial Number
Date of Manufacture
Location
Quantity
Location
Width
Height
Stacking Retrictions
Required Clearance
Dunnage Requirements
Temperature Limits
Security Requirements
NEW
Inhabited Building Distances
Explosive Class
Explosive Division
Condition Code
Risk Category
Compatibility Group

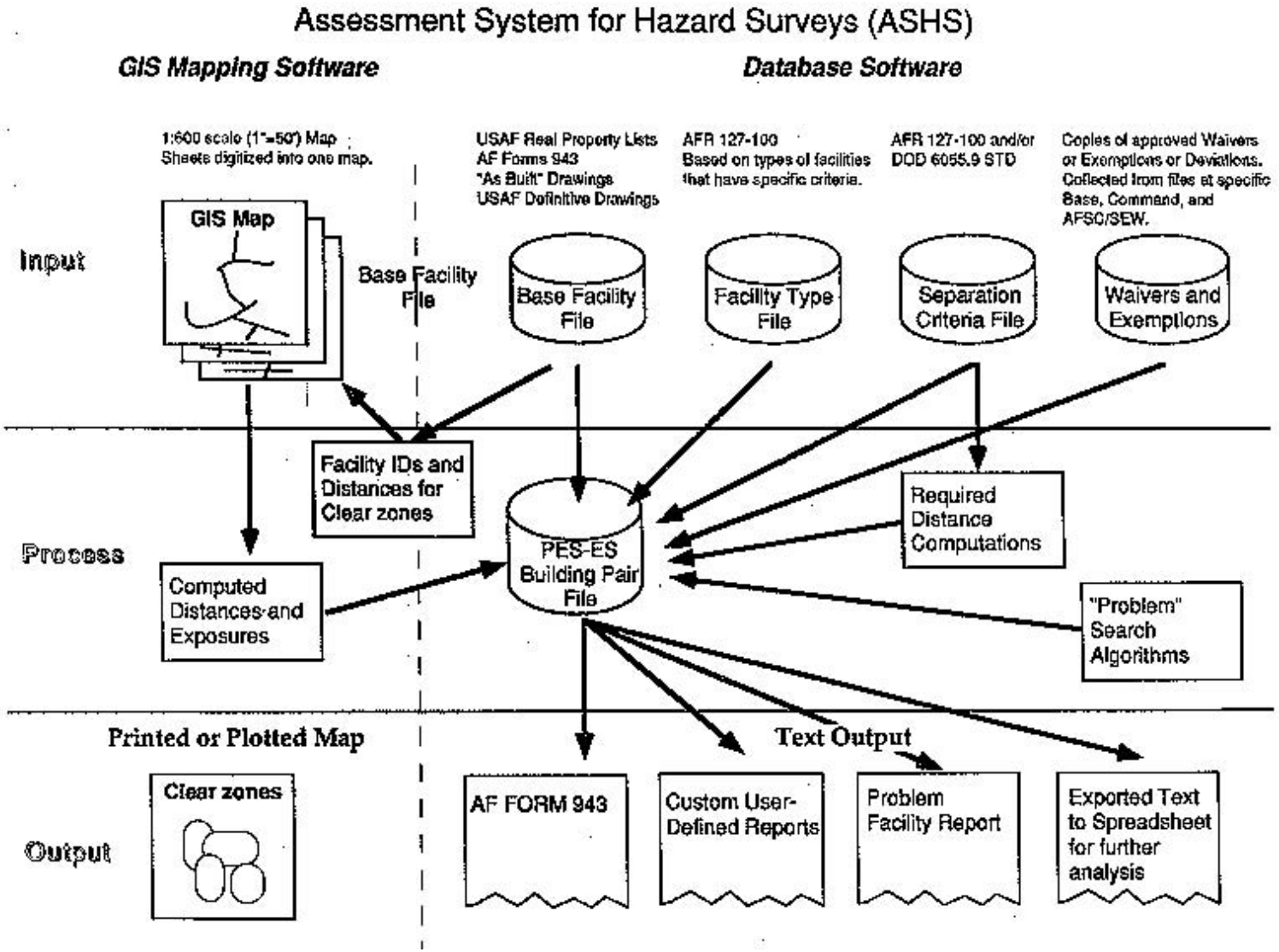

Assessment System for Hazard Surveys (ASHS)
GIS Mapping Software
Database Software
1:600 scale (1"=50') Map Sheets digitized into one map.
USAF Real Property Lists
AF Forms 943
"As Built" Drawings
USAF Definitive Drawings
AFR 127-100
Based on types of facilities that have specific criteria.
AFR 127-100 and/or DOD 6055.9 STD
Copies of approved Waivers or Exemptions or Deviations. Collected from files at specific Base, Command, and AFSC/SEW.
Input
GIS Map
Base Facility File
Base Facility File
Facility Type File
Separation Criteria File
Waivers and Exemptions
Facility IDs and Distances for Clear zones
Process
PES-ES Building Pair File
Required Distance Computations
Computed Distances and Exposures
"Problem" Search Algorithms
Printed or Plotted Map
Text Output
Output
Clear zones
AF FORM 943
Custom User-Defined Reports
Problem Facility Report
Exported Text to Spreadsheet for further analysis

Figure 2

Summary: The Air Force EHR program is highly successful. It identifies, quantifies, and prioritizes risks presented by munitions to operations. The analytical capability developed by the program, which includes the Air Force's Assessment System for Hazard Surveys (ASHS), provides the user with the ultimate "mission management capability" need to assure the maximum logistic survivability of our war fighting assets.

The Defense Environmental Security Corporate Information Management (DESCIM) Program Management Office (PMO) has completed its joint Component review of candidate migration systems for the Site Planning Functional Sub-Activity of the Explosives Safety Management functional process.

The DESCIM PMO convened a joint Component Site Planning Functional Work Group to determine functional requirements, develop system selection criteria based on those requirements, and to evaluate the Component nominated systems. The Air Force's Assessment System for Hazard surveys (ASHS) converted to operate on Open System Environment (OSE) Hardware was identified as the recommended solution to meet the functional requirements.

The recommendation was approved. The ASC/LIW (EHR) Program Office is executing the program to migrate ASHS for universal DOD use.